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MEDICAL RECORD AUTOMATION AT THE LOS ALAMOS SCIENTIFIC LABORATORY

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Abstract

With the increase in population at the Los Alamos Scientific Laboratory and the growing concern over employee health, especially concerning the effects of the work environment, the Occupational Medicine Group decided to automate its medical record keeping system to meet these growing demands. With this computer system came the ability for long-term study of the work environment versus employee health, but other benefits such as more comprehensive records, increased feasibility, reduced physician time, and better records management.

1. INTRODUCTION

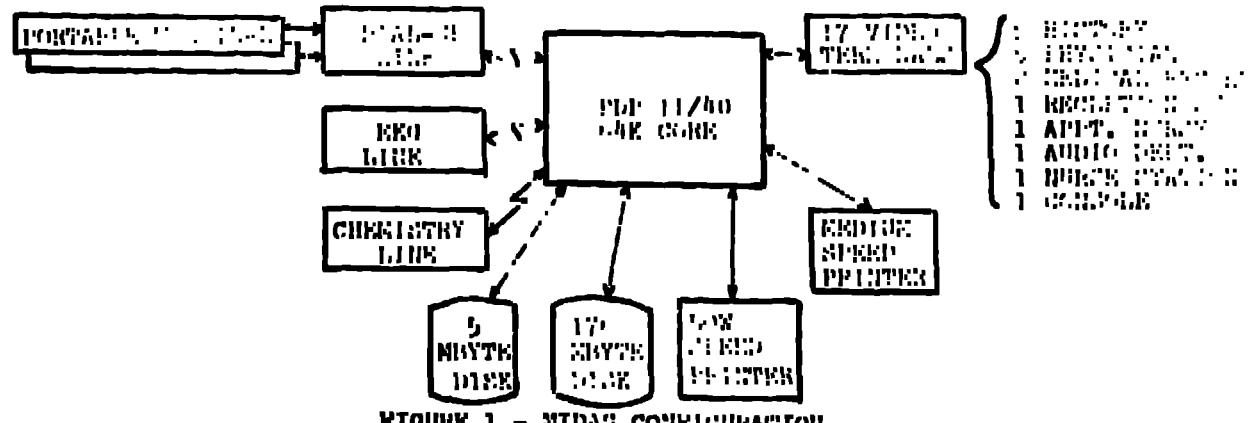
While the practice of occupational medicine has many dimensions, the basic ingredient is the employee; all efforts of an occupational medicine program are directly or indirectly concerned with the welfare of the employee through efforts to provide a safe workplace, to assure prompt and effective treatment in the event of occupational injury or disease, and to help the employee maintain optimum personal health and well-being. There is a basic question that needs to be answered by every occupational medical department - namely, "Is the working environment adversely affecting the health of the employee?" This question must be answered not only for each occupational medicine department, but for the government as well, with the advent of the Occupational Safety and Health Administration (OSHA) in 1970. In order to provide such answers a data base covering the period of the employee's career is required. The fundamental ingredient in this data base is a complete baseline medical evaluation of each employee that is

periodically upgraded. In addition to the medical evaluation it is necessary to know the individual's past and present work history, and insofar as possible, the conditions of his work environment, such as exposure to noise, solvents, radiation, carcinogens, metals, and fumes. Over the years at the Los Alamos Scientific Laboratory (LASL) there have been vigorous Industrial Hygiene, Radiation Protection and Safety Programs. A great deal of data has been accumulated and only portions of this data are in the employee's medical record, often in a form so dispersed, that it is difficult, if not impossible, to correlate and use advantageously. Other pertinent data is stored in separate systems from the medical record system, making physician utilization almost impossible. Late in 1973 the Occupational Medicine Department at LASL began to explore ways of developing a medical record system to meet the record keeping demands of a growing employee population and the vigorous growth of protective standards by the Department of Energy (DOE) and OSHA. After exploring a number of al-

terminal, the robot director and programming extender. At that software prototype, it was decided that a network of medical records offered the best means of meeting these demands. Such automated records would facilitate future analysis and research. In answering the question concerning effects of the work environment upon employee health, additionally, diagnostic tests could be realized such as, 1) easier and more accurate data capture, 2) less lengthy, comprehensive and accurate records, 3) better use of medical personnel, 4) increased efficiency of record management, and 5) potential for system growth.

2. SYSTEM OPERATION

The Redden Information Display and Acquisition System (MIDAS) in Figure 1 is configured using a Digital Equipment Corporation (DEC) PDP11/40 processor running the DEC RSX-11 Operating System, with 64K of core memory, one 176 Megabyte disk, two 2.5 Megabyte disks, a medium speed line printer, a low speed line printer, 17 video terminals, a ported to minicomputers coupled terminal, an optical tape source reader, a telephone connection to a pulmonary function analyzer, a television-conference call switcher, and three telecommunications links for data transmission.



3. SYSTEM OPERATION

In MIDAS we have attempted to apply the knowledge gained from previous medical information systems,本着 our efforts to simplify data entry and retrieval. Rather than the physical transport mechanism, or paper and pencil technique, in MIDAS the patient's medical history is taken interactively at one of five video terminals under software control, *similar to what the patient himself should contribute and begin going to his own care by taking a self-administered data base history.* (1) In those cases where medical data is not effectively gathered directly from medical equipment, such as pulmonary or EKG data, it is entered using user readable terminals. Retrieval from the data base requires making simple selections from menu presented on the video terminals. To show the best way to show how the system works is to follow an individual through the medical evaluation and show how the computer plays a part in such an evaluation and the generation of the medical data base.

To begin the appointment, name current employee, for scheduling the next employee or computer station that contains the data. "the employee to that evaluation, the time, interval, reasons listed before evaluation, and any diagnoses or problems.

To set up a site date, the receptionist calls an employee to schedule him, then on the day prior to his first of the two visits for his evaluation. The receptionist then enters the scheduled data into the computer at one of the video terminals, using a modification of the computer code (2) to locate his data in the system for inclusion on the schedule. The scheduled data includes a profile of required tests, depending upon the previous test results and length of time since the last test. Thus, employees receive chest x-rays every three years unless otherwise indicated. The computer then generates a letter for authority to treatment to be given to the employee that tells him what he can expect and what to expect of his during the evaluation.

On the day before each scheduled employee's first visit, the receptionist prints human body machine readable identification data on the front of their medical record (one for physician, pathology, laboratory, one for a chest x-ray report, and one for laboratory pathology). The identification data includes the patient name, middle initial, and state of birth from which he originated by the employee's residence as well as the date due for the next visit. This schedule is broken into three parts: 1) those employees scheduled for the first visit of the evaluation, 2) those employees who are scheduled for the second visit of the evaluation, or for a repeat visit with the physician, and 3) those scheduled for any special evaluation such as ergometry, inner ear examination, pulmonary workup study and so forth).

On the day of the first visit the employee arrives having fasted since the evening before and is directed by the receptionist to the front desk of several staff in the medical department in the building. He is given a route book clip to be checked out for

completion each part of the evaluation. For this example assume the employee is sent first to have his blood drawn and to leave a urine sample. The laboratory technician draws a blood sample into a pre-labeled test tube and instructs the employee where to place the pre-labeled test stat after it is completed to be read. The employee is sent to the X-ray section where, if indicated by his profile in the schedule, a chest and/or abdominal internal x-ray, a urinalysis performed. Next, one of the nursing services takes records on the work done from the employee to height, weight, B.I.C. pressure, and vital data. A twelve lead electrocardiogram is then taken with the raw data transmitted over telephone. Then the employee to Chicago that is home the report to him over one of the telephone lines in the office. The next step is to test the employee's pulmonary function and the heart's left function. Both sets of results are transmitted directly to ERIC, then re-enter the status of human errors. The employee then returns to the receptionist who instructs the employee in the use of the interactive history compilation terminal and starts him on the self-assessment data base history. The patient must verify the accuracy of the identification information about himself before taking the history. If any data is incorrect, it is immediately corrected and the employee is re-started on the history process. For those employees who require assistance in taking their histories in this manner, the receptionist will spend as much time as necessary to assist the employee. For approximately the next 45 minutes the employee answers 100 to 115 multiple choice questions about his family history, his own health and work history, and his own symptom review. The actual number of questions depends upon branching associated with his responses. Response by the

patients have been asked to respond to an approximate set of questions either to perform or not. They prefer this method over an approximately 10% who prefer the physician-patient exchange.

The questions in the history are based on the work done by the University of Wisconsin in a similar interview history questionnaire procedure. We have modified quite a number of questions to the industrial history, with sections written for future industry. In addition, specific questions concerning the job history, including industry, occupation, exposure, and so forth. There is now an industrial history given when the employee returns for subsequent visits which may refer back to those areas of the history that may have changed since the last visitation.

At a third step the employee goes to the appointment room to set a convenient time and date for his second visit. The appointment time and date are chosen from the available times for a particular physician on the computer schedule. That time interval is automatically deducted from that physician's available appointment times. The appointment is entered in the daily schedule for that day and the appointment is noted on the routing slip to remind the employee of his second visit. An extra appointment card is also appointed, the appointment being valid until the employee on the morning of the second visit.

After the first visit testing is complete, the laboratory technician analyzes the blood and urine samples, recording their results on the laboratory mark sheet form. The blood serum is prepared and delivered to a local laboratory where chemistry profiles are run and the results are transmitted orally on one of the telecommunications links directly to EIDAS, thus elim-

inating the transmission errors as possible. Similarly, the x-ray films are processed and then read by the radiologist who records his findings on the x-ray mark sheet form. Any additional comments are dictated for inclusion in the final report. All of the mark sheet forms for the day are then read on the screen of the X-ray reader and the x-ray report is generated with different question procedures. The more common history items are repeated, the information in the employee's report, and if necessary, a new x-ray report is generated. Distribution of comments are then sent to the report in the patient's record.

On the day prior to the employee's second visit, the appointment nurse verifies on her terminal that all data is pulled in available. On the day of the second visit, the physician reviews the test results with the patient, verifies and elaborates on the history and performs the physical examination. The physician reports the physical examination at his terminal, i.e., on the patient's own medical history. If the results of part of the examination are normal, the physician branches out and further questions in that system continue and present to the next system until no questions. At the conclusion of the examination, the physician enters any comments to be made for the internal medical consultation of Physicians, Adverse Effect, as well as any other pertinent findings or recommendations for his treatment. The physician can also request EIDAS to perform a coronary risk assessment, based on the available data as compared to the Framingham Study (3).

4. FUTURE DEVELOPMENTS

A large number of employees are seen for occupational illnesses and injuries. Each visit is presently recorded on a daily log with ICDA codes and then is transcribed in-

to the employee's paper records. In the near future the nursing staff will also determine to record these visits, entering the data from a menu-driven program directly into the computer record. The work done on the COSTAR encounter forms will serve as a basis for the menu-driven code (4).

To complete the data base for studying work environment versus employee health, data from other storage systems must be incorporated into MIDAS. The Health Physics Group must be incorporated into MIDAS. The Health Physics Group at LASL has been storing individual radiation exposure records in computerized form that is soon to be transportable to MIDAS. Plans call for incorporating quarterly the cumulative exposure records in each individual's medical record. The Industrial Hygiene Group has bioassay records, tile sample records, hazard location, and radio level measurements that are presently in a separate computer system. The patient information from this system will also be incorporated as part of the patient data base. Ultimately MIDAS will have a complete profile of such occupational data for each employee. The profile will include the employee's work history and exposures (potential, radiation and chemical), bioassay data, hazard data, health risk and work restrictions. Part of this profile exists in the *work* work location, *bioassay*, *handling* and *work restrictions*. This profile will be called up at the physician's desk or at a computer dispenser.

A great deal of previous medical documentation for employees is stored on microfiche. MIDAS will continue to incorporate microfiche storage so that documents that are taken from the old paper record or the new computer-generated or not easily converted to another format

media. To make this data readily available to the physician and to future data base studies, MIDAS will incorporate computerized retrieval of microfiche. The information on the employee's microfiche containing specific patient information can be called up by the physician to provide the exact frame or frames in the microfiche. In this manner future research can be partially automated in the microfiche data base, at least to the point that MIDAS could search for specific categories of employee data and determine the location of that data for further analysis on this select group. Such data will be made available to the Epidemiology Studies Group for analysis, especially relating to plutonium workers.

4.3 EVALUATION

With this constantly growing record data base, MIDAS is quickly approaching the point where effects of the work environment upon employee health can be studied on a large scale. One analysis of the data base has been done and has proven useful in identifying employee health loss versus the working environment. Individual employee coronary risk assessment by the system is being done to provide the incentive for preventive health care by the employee. Other anticipated benefits have been realized from the medical record automation. The legibility and readability of medical records is greatly improved due to the accessibility to the data base via terminals, reducing hand copy and all its associated problems (misplaced charts, misfilled reports, etc.). The physician is able to spend more time with the employee due to decreased laboratory requisition time as well as reduced time in reporting the physician examination. The physician actually spends about the same length of time with the patient as

before; however, the time previously spent in history acquisition and reporting is now spent answering specific questions and concerns of the employee, providing more quality care. In addition, the radiologist's report generation time has been significantly reduced by the automation in their portion of the evaluation. As more of the employee's records are entered into EMIS, any adverse effects of the environment will hopefully be identified through joint efforts of the LASL staff who receive employee health and safety data and thereby provide means to make the work environment safe for the employees.

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BIOGRAPHY

Guy Beagle is the systems engineer for the Occupational Medicine Group at the Los Alamos Scientific Laboratory (LASL). He received his B.S. in bioengineering at Northeastern University, Boston Massachusetts in 1972, and his B.S. from the U.S. Airforce Academy, Colorado Springs, Colorado in 1966. Prior to joining LASL he worked on the Air Force project for computer automation of the Automated Armed Forces Examining and Entrance Stations for inducting draftees.

Robert S. Grier is currently the Group Leader of the Occupational Medicine Group at the Los Alamos Scientific Laboratory (LASL). Dr. Grier graduated from the Harvard Medical School in 1941 and completed his residency in medicine at Massachusetts General Hospital in 1943. His service at Massachusetts General Hospital was followed by a tour of duty with the Coast Guard Academy as Chief of Medical and Radiological Services from 1944 to 1945. He returned to Massachusetts General Hospital in 1946 where he worked on toxicology of beryllium and treatment of tumors by chemotherapy and immunotherapy. He left Massachusetts General Hospital in 1949 to serve as group leader of the Occupational Medicine Group at LASL until 1954, when he returned to practice at Massachusetts General Hospital in cancer hormonal and chemotherapy, as well as working on the study of metabolism of molybdenum. In 1973 he returned to LASL as Group Leader of the Occupational Medicine Group, where he has directed the growth of the automated occupational medical record system.